# CONSERVING CORN FROM WEEVILS IN THE GULF COAST STATES

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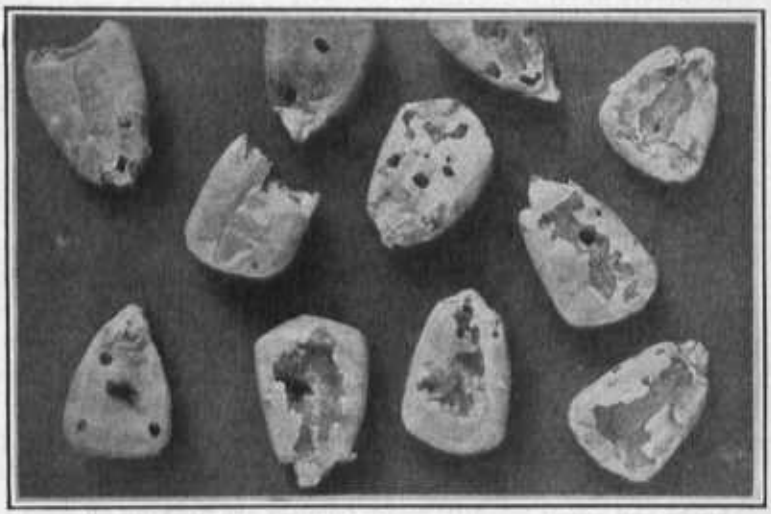

FARMERS' BULLETIN 1029

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
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CONSERVATIVE ESTIMATES place the average weevil loss of southern corn at 10 per cent. In very many instances, particularly on the small farm, it is much greater. It is a loss that can be prevented. Preventing weevil damage pays handsome returns. Control of weevils is simple, if given a proper place in farm economy. This bulletin gives information that if heeded will save the southern farmers millions of dollars every year. The results will be immediate and visible.

The farmer can keep his corn safe from weevil attack until he can sell to advantage or turn it into meat. The farmer can do for himself what the speculator has found it profitable to do for the farmer. It is unbusinesslike to sell corn in the fall, or as soon as weevils are discovered, merely to avoid further weevil loss. Where attention is given to weevil control, farmers are saving money.

Methods of controlling weevils are discussed on pages 15–36. It will pay to give heed to special details, such as the planting of selected corn, use of trap rows, and early and thorough harvesting. Take advantage of nature's protection from weevils in the form of a long, tight, uninjured husk by placing all such ears in a separate crib. They will keep indefinitely.

Always husk the ears with loose, broken, short, or damaged shucks. They are usually weevilly at time of harvest. Poorly protected ears should be fumigated to kill the weevils or fed to stock during fall. It pays to fumigate even corn that is to be fed during a two-month period after harvest.

Because labor can not always be depended upon to separate carefully ears with good from those with poor husk covering, and because several kinds of insects can ruin husks and admit weevils, many farmers are husking all corn and protecting it in cribs or rooms by fumigation with carbon disulphid. Carbon disulphid is a good fumigant for killing weevils. The number of fumigations necessary, the relative space occupied by corn in husk, slip husked, and husked, the cost of fumigation, and the amount of carbon disulphid to use for each 1,000 cubic feet of space are discussed in this bulletin.

Have your own fumigatorium, no matter if it be a crib, box, pail, or room. For success, the fumigatorium must be gas tight, or nearly so. This bulletin tells how others have built containers and have succeeded in fumigation. They are enthusiastic over losses prevented. Anyone can do as well. County agents can help in no better way to conserve the food supply of corn throughout the South than by spreading the information contained in this bulletin and by making fumigation cheap through cooperative buying of carbon disulphid.


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# CONSERVING CORN FROM WEEVILS IN THE GULF COAST STATES.

CONTENTS.



## CORN AND SOUTHERN AGRICULTURE.

THE GREAT FUTURE of the corn crop of the Southern States is assured. The South can raise excellent crops of corn, and this crop, with the development of diversified farming, will play an increasingly important part in the feeding of the Nation. The South is destined to become the greatest section in this country for meat production upon the farm. The protection of her corn crop from insects is of vital importance.

## WEEVILS DESTROY CORN.

If the southern farmers are to reap the benefits of increased yields of corn, they must give thought to the protection of this crop from insect attack. It is estimated that weevils destroyed 1,260,000 bushels, or 10 per cent, of Florida's corn crop of 1916, and Florida has only begun to grow corn. In 1912 Alabama raised 54,000,000 bushels of corn, which suffered through weevil attack to the extent of at least $4,000,000 according to her State entomologist. The various county agents of South Carolina in 1911 estimated the losses caused by weevils to the corn crop of that State to range from 2 to 75 per cent, according to the location of the county, with an average loss for the State of 13.8 per cent of the 29,646,000 bushels raised that year. There is no denying the fact that the annual losses upon farms throughout the South as a result of weevil attack are great, that the average farmer looks upon such losses as a necessary evil, and that he does nothing or little to protect himself from

them. To minimize the loss he often sells his corn to large dealers in the fall when prices are low, only to buy it back later, in smaller quantities, in many instances, when he needs it either as food for his family and animals, or as seed, at prices all out of proportion to what it would have cost him to save it from weevils on his own farm until he could take advantage of a better market or until he could profitably use it for the home production of beef, pork, etc.

## NOT NECESSARY TO SELL EARLY TO AVOID LOSS.

The farmer can keep his corn safe from weevil attack on the farm until he can either sell to advantage or turn it into meat. Certain farmers are holding corn for over a year without weevil injury by careful attention to storage and fumigation. What has proved profitable for a few can be made equally profitable for all. The cry that comes to the Department of Agriculture from all the Southern States, from Mexico, Central America, portions of South America, Cuba, Santo Domingo, etc., is, "We can grow good crops of corn, but it is eaten up by weevils. What can we do to save our crop?"

## THE FARMER CAN DO FOR HIMSELF WHAT THE SPECULATOR HAS FOUND IT PROFITABLE TO DO FOR THE FARMER.

If the up-to-date business man or organization with money can find profit in buying corn from the small farmer at a low price in the fall when the harvest is gathered and corn is plentiful and hold it in storage with an occasional treatment to prevent loss from weevils, the farmer can find an equal profit in holding his own crop and protecting it from weevils until he can dispose of it to advantage. It is unbusinesslike to sell corn in the fall, or as soon as weevils are discovered in it, merely to avoid further weevil loss. The farmer who to-day is making the most of his opportunity has found that it pays to give to the protection of his corn crop from insects the same care that he gives to the planting and cultivation of the corn plant itself.

## FARMERS MAKE MONEY BY KILLING WEEVILS.

Mr. R. L. Clute, formerly special field agent of the Bureau of Entomology in Florida, has reported the following three instances in Florida that show how the small farmer can make money by fighting the weevil. How a large plantation in Louisiana made money and conserved 1,000 to 1,500 bushels of corn at the same time is told on page 33.

One farmer in January, 1918, marketed a load of ear corn that weighed 2,000 pounds. In March, 1918, a load of equal size from the same bin was marketed but weighed only 1,600 pounds. The differ-

ence in weight of 400 pounds, or 7 1-7 bushels, represents a loss due largely to the feeding of weevils between January and March in central Florida. In other words, 20 per cent of the crop was lost through weevil attack, and at $2 per bushel (in 1918), this represents a loss of $14.28 on this one load. The farmer could have saved practically all this had he given as much attention to the housing and treatment of his corn as he gave to feeding his horses.

A farmer in Marion County, who found that his corn was weevilly when it was harvested in 1917, spent $13.45 to convert a carriage shed into a gas-tight crib large enough to hold 150 bushels of corn. For less than $1 he treated 100 bushels of corn placed in this crib in the fall. After holding the corn 45 days he sold it at 25 cents per bushel more than the price he was offered for it at harvest time. Without fumigation he could not have saved his corn without loss. By proper treatment he not only got back the cost of the crib but made a profit of about 72 per cent on his investment for the year and still had his crib left for succeeding years.

Another farmer in Suwanee County made a fumigation box of rough lumber lined with heavy paper, large enough to hold 100 bushels of shelled corn. In October (1916), just after harvest, he filled the box with sacks of shelled corn and fumigated with carbon disulphid to kill the weevils. The following April (1917) he sold his protected corn for $1.35 a bushel, while his neighbors, who had not treated their corn, received not more than $1 per bushel.

These are only a few instances of the gain that the small farmer can reap by properly protecting his corn from weevils. Treatment pays handsome returns.

## INSECTS THAT INJURE CORN IN STORAGE.

Two insects do more injury to corn in storage than all others combined, the rice or "black" weevil[1] and the "fly weevil" or Angoumois grain moth.[2] Other moths similar to the Angoumois grain moth, however, numerous small, brown or black beetles, and two kinds of grain borers usually are present in granaries in larger or smaller numbers. While under certain favorable conditions they cause as much damage as the "black" weevil and Angoumois grain moth, they will not be discussed at length, for in localities where they are sufficiently abundant to cause serious injury the rice or "black" weevil, or the Angoumois grain moth, is also present and any treatment that will kill these two pests will kill other insects as well.

This bulletin makes no attempt to give information regarding all of the insect enemies of corn in storage.

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[1] *Calandra oryza* L. [2] *Sitotroga cerealella* Oliv.

## THE ANGOUMOIS GRAIN MOTH.

The Angoumois grain moth, sometimes called the "fly weevil," is in many parts of the country the most serious pest of corn in storage. The adult moth or miller is present both in the field and in the storage house or crib. It is a delicate moth measuring not more than one-half an inch from tip to tip of its wings; it is light gray to buff in color with a minute black spot about midway of each wing. It has a quick, erratic flight and is usually entirely overlooked when it rests quietly upon corn husks or the sides of the crib.

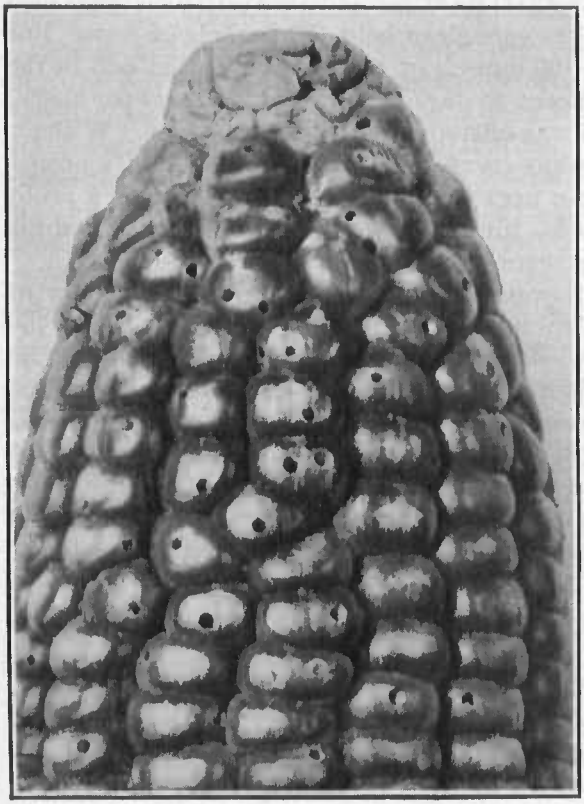

FIG. 1.—Tip end of ear of corn showing the round holes in the kernels made by the Angoumois grain moth. For a side view of the kernels thus affected see figure 2; for an interior view see figure 3.

This adult lays its eggs upon the exposed kernels in the field or on the corn in storage. The eggs, which appear as mere specks, are whitish when first laid but later turn reddish. They are laid singly or in masses at the base of the kernel and hatch in a few days.

The young larva or "worm" that hatches from the egg is seldom seen, not only because it is so small but because it bores at once into the kernel, usually at the base, and, as soon as it has eaten out of the kernel a hole large enough to conceal itself, it spins a web over the entrance. Once in the kernel the larva continues to feed on the interior and in warm weather becomes full grown in about three weeks. When full grown the larva is about three-eighths of an inch long. It then eats a round tunnel to the outside of the kernel; this done, it neatly spins a silken lining across the round opening and along the sides of the tunnel and cavity in the seed that it has made while feeding.

After the larva has made this silken chamber or cocoon, it transforms into a pupa or chrysalis as shown in figure 4. The pupal period lasts from 6 to 10 days in summer and then the adult moth emerges, crawls out of the kernel by pushing aside the silken web over the entrance, and is ready to mate and lay eggs for the next generation of larvæ. In warm weather, one generation may require not more than 5 or 6 weeks.

**Detection of infested kernels not easy.**—As the eggs of the Angoumois grain moth are laid at the base of the kernels and as the larva bores into the seeds at this point and feeds entirely within the kernel until it tunnels to the surface just before transforming to the pupa, it is very difficult for the average person to tell whether his crop is being attacked without an exceptionally careful examination of his corn. Usually the first evidence of infestation that he observes is the large number of moths that fly up in clouds when anything is disturbed suddenly in the granary, and the many small, round holes, less than one-sixteenth of an inch in diameter, through which the moths have left the kernels. These holes are shown in figure 1. If the ear shown in figure 1 be broken, as shown in figure 2, the kernels will appear sound, for it is seldom that the Angoumois grain moth leaves the kernel except at the tip. But if these same kernels, which appear unaffected in figure 2, are cut open as shown in figure 3, many will be found to conceal the tunnels or burrows made by the worms while eating out the corn. A kernel, magnified (fig. 4), has been cut open to show a pupa in the silken cocoon and the tunnel to the outside along which the moth will escape when it emerges from the pupa.

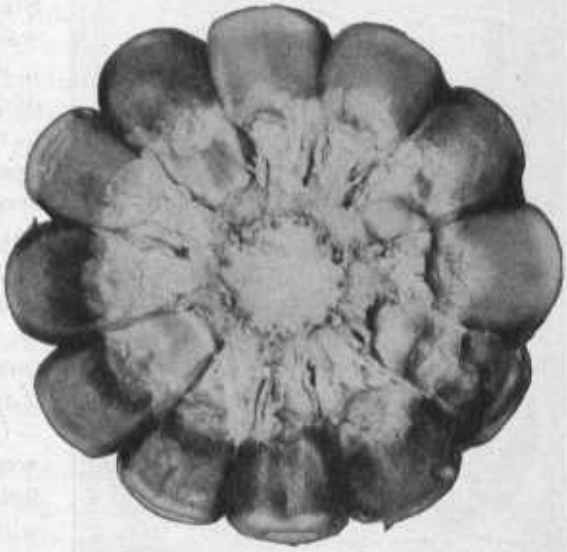

FIG. 2.—An ear of corn badly damaged by the Angoumois grain moth, broken in two to show how perfect the kernels appear when viewed from the side.

**Does not affect corn well protected by husk.**—The Angoumois grain moth can not attack corn that is protected by well-fitting, close husks.

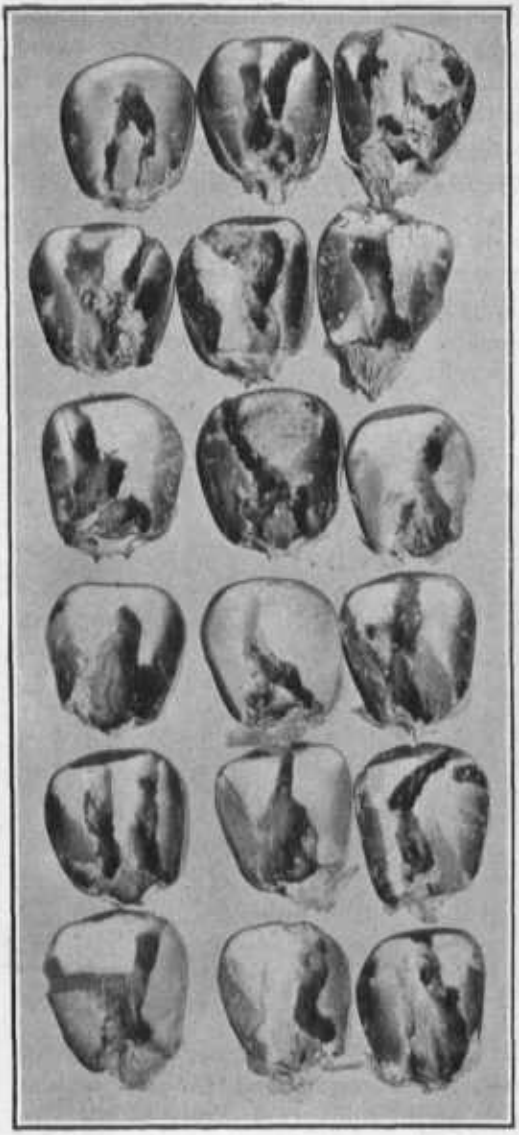

FIG. 3.—Kernels of corn cut in two to show the damage caused by the larva or worm of the Angoumois grain moth. The worm usually enters the seed at the base, destroys the germ, and then tunnels toward the tip of the kernel. Affected kernels nearly always are ruined for planting purposes.

## THE RICE OR "BLACK" WEEVIL.

This pest is called by many the rice weevil, because it was first found attacking rice, but it is just as serious a corn or wheat pest in all warm countries and is more popularly known throughout the southern part of the United States as the "black" weevil. The weevils vary in color from black to reddish-brown and usually have four reddish spots upon their backs. These spots are most evident on dark specimens. Every farmer should know certain facts about this enemy of corn, wheat, and other cereals, that he may fight it intelligently.

(1) **The adult "black" weevil can fly from crib to field.**—The adult weevil, which is not more than three-sixteenths of an inch long when its head is extended, can fly. During early summer many weevils leave the cornerib and fly to the fields. Some pass the winter hidden in neighboring woods and other sheltered places as well as in the cribs with the corn. They begin to appear on corn plants when the corn approaches the roasting-ear stage, no matter what time of the year this may be. The writer found weevils laying eggs in sweet corn at Sanford, Fla., on May 8, 1918, and they were most abundant within 100 yards of a badly infested cornerib. Farther north the date of

appearance in the field will be considerably later. These weevils fly readily at certain seasons of the year. Large numbers have been captured while flying over wheat fields in Kansas at an altitude of 50 to 100 feet.

(2) **Weevils concentrate on early-maturing corn.**—Weevils concentrate their attack upon early corn, sometimes to such an extent that late corn is little attacked.

(3) **The weevil does not usually eat through shucks or husks.**—Investigators state that the adult or parent weevil can not eat holes in the husk covering the ear, but this is not always true. Dr. F. H. Chittenden and the writer have observed weevils riddling shucks, especially when they have become very abundant and have destroyed practically all the kernels on the cob. Ears with long, tight-fitting and uninjured husks usually do not become infested (fig. 5).

FIG. 4.—Cross section of one of the kernels of corn in figure 3 enlarged, to show the cavity made by the larva of the Angoumois grain moth, the silken chamber formed by the larva, before transforming to the pupa. The large brown or blackish appearing object is the pupa from which the moth will emerge and crawl along the silken channel in escaping from the seed.

(4) **Weevils attack exposed ears and ears with loose or damaged husks.**—In the field weevils attack ears the tips of which stick out beyond the husk, and ears poorly covered with a loose or damaged husk (figs. 6, 7).

(5) **Weevils are protected by loose or poor husk covering.**—Loose and poorly developed husks do not protect corn, for the adult weevils are so small that they can crawl down between the leaves of these husks and so reach the corn; or if the tip of the ear is exposed, the weevils can easily crawl down from the tip along the kernels to the very butt (figs. 6, 7). In the case of poorly protected ears the husks actually favor weevil increase.

(6) **The weevil passes through different stages in its growth.**—The mother weevil lays her eggs in the kernels of the corn. With her jaws, which are at the end of the long snout or proboscis of her head, she eats out of the kernel a small cavity in which later she lays an egg. She then covers the egg with a cementlike secretion which makes it difficult to tell where the egg has been laid. From this egg the small grub, not as large as the head of an ordinary pin, hatches

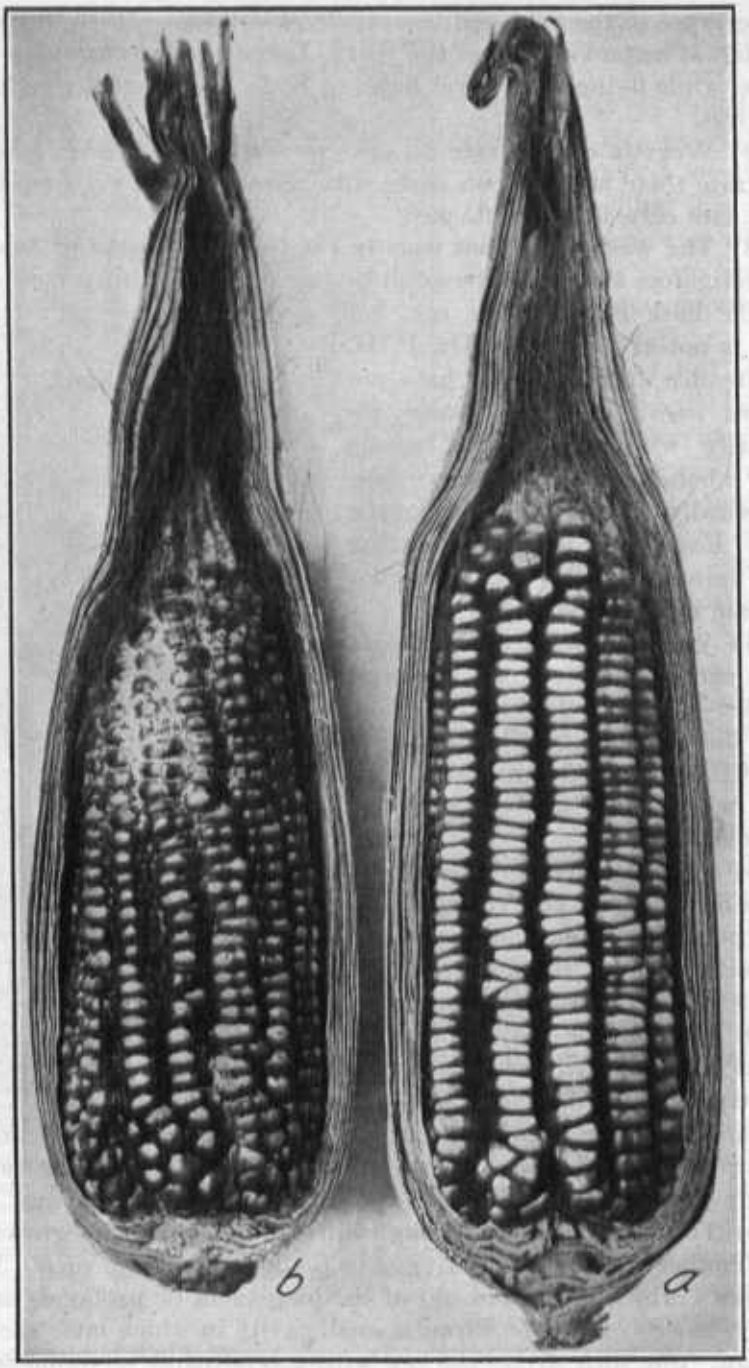


FIG. 5.—Ears of corn with the long, tight shuck covering that prevents weevils from injuring the corn. Note that the silk is uninjured in both cases. Ear *a* is so perfectly protected by its shuck that its kernels will never become affected by weevils if nothing happens to injure this protective covering of nature. The covering of ear *b*, which, under normal conditions, would have been protected just as well as that of *a*, has had a hole eaten into it by the corn earworm. The shuck containing the hole has been cut away to show how weevils entered through the earworm hole and began devouring the kernels.

FIG. 6.—Ear of corn with a poor, loose shuck. It is badly infested with "black" weevils. As the adult weevils feed, they push from the kernels the chewed-up portions, frass, etc., and this material, resembling white dust, collects in large quantities between the kernels and the shuck, or, if the ears are shucked, it falls like powder onto any object below the ear.

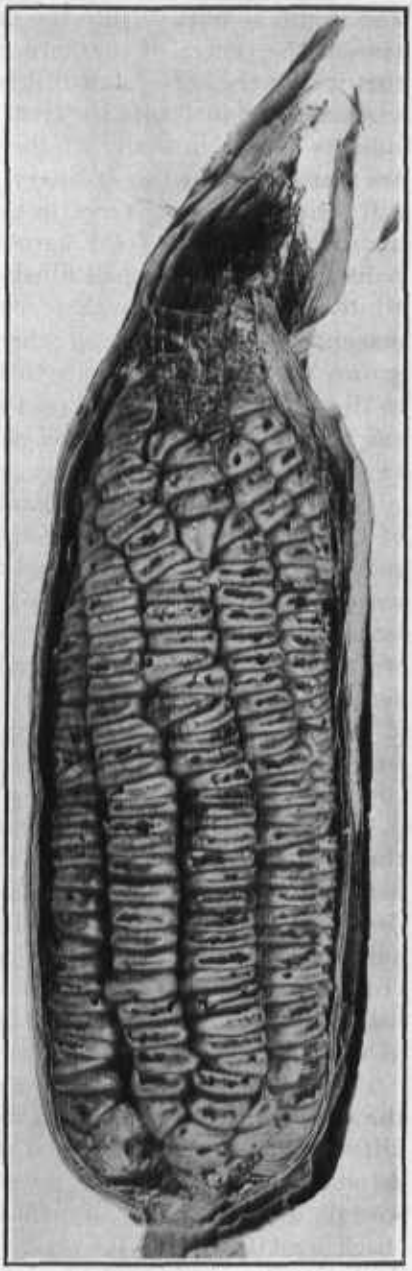

FIG. 7.—An ear of soft corn badly damaged by weevils, similar to that shown in figure 6. This ear has been hit against a table to jar loose the powdery substance, sometimes called the farinaceous material, and so reveal the great damage done by the weevils. The kernels of the ear have been reduced to powder and shells.

and begins to burrow into the kernel. When the grub bores directly toward the center of the kernel there is almost no sign to indicate that it is in the kernel, but if it burrows parallel to and just along the surface its tunnel appears from the outside as a long, narrow, pale line, as shown in many of the kernels of figure 8. These tunnels are more often seen in ordinary flinty red or yellow corn than in the soft white varieties. Once in the kernel, the grubs continue to feed upon the contents of the kernel, and when numerous enough they reduce the seed to a shell filled with powder. The grubs are legless, white, thickened, somewhat curved in outline, and not more than one-eighth of an inch long when well grown. Upon becoming well grown the grub transforms to the pupa, which in turn transforms to the adult weevil. The insect upon becoming an adult eats its way out of the kernel, leaving behind the small, irregular holes familiar to all. It then mates and lays eggs for the next generation.

(7) **Time required for a generation.**—During the warm weather of the South weevil eggs hatch in about 3 days. The grubs become full grown in 15 to 19 days and the pupa stage requires about 7 days more. The immature stages of a generation in warm weather may be passed in 25 to 29 days. It is not known just how long the adult weevil lives, but it is quite a number of days, weeks, or months under certain conditions. Each female lays so many eggs that the weevils, if unchecked, multiply with great rapidity. Naturally the length of time required for a generation depends very largely upon climatic conditions.

(8) **Weevils breed generation after generation in corn, both in the field and in storage.**—The longer corn is allowed to stand in the field after it has ripened, the larger the number of weevils that can develop in it and the larger the number of weevils in kernels and among the shucks ready to be carried into cribs and barns when the crop is harvested. In the extreme South corn is sometimes left in the field so long after it is ripe enough to harvest that several generations of weevils can mature and cause great damage.

(9) **Cold weather can not be depended upon to kill weevils in the Gulf Coast States.**—Cold weather can not be depended upon to kill weevils in corn throughout the more southern States. The State entomologist of Alabama states that at 20° F. large numbers of weevils die. The cold of winter in central Alabama may, indeed, check weevil activity for about two months during midwinter, and doubtless does kill many weevils under certain conditions, but cold weather, such as is experienced in the warmer portions of the Gulf Coast States, can not protect corn from weevils to such an extent that it should be depended upon for protection. Weevils causing injury to corn in storage during the fall and early winter, before the

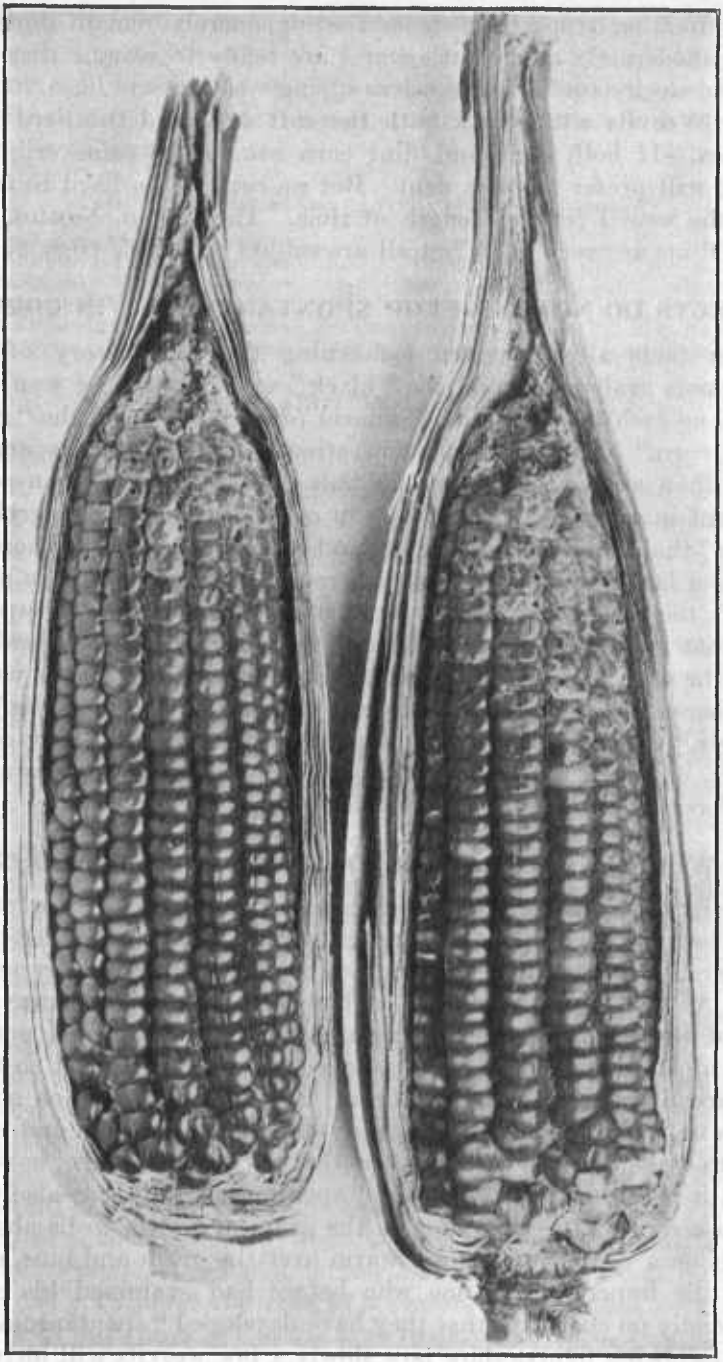

FIG. 8.—Two ears of corn with a short extension of shuck covering beyond the tip of the ear. Note that the protective feature of the husk has been destroyed by the eating out of the silk by the corn earworm. These ears were photographed in December following the harvest. By the following March to May, the weevils would have spread to the kernels at the base of the ear.

coldest weather stops them from feeding, merely remain dormant during moderately cold weather and are ready to resume their destructive work as soon as the warm spring weather sets in.

(10) **Weevils will attack both the soft dent and the hard flint varieties.**—If both dent and flint corn are in the same crib, the weevils will prefer the soft dent. But no corn is too hard to withstand the weevil for any length of time. The Cuban, Nassau, and Creole flints are very hard, but all are subject to attack (figs. 8, 12).

## INSECTS DO NOT DEVELOP SPONTANEOUSLY IN CORN.

From facts already given concerning the life history of the Angoumois grain moth and the "black" weevil it can be seen that there is no such thing as a development of an insect from the "germ of the corn." "Spontaneous generation" occurs no more among insects than among the higher animals. There is always an adult or parent insect which lays an egg in or on the corn and a grub or "worm" that hatches from this egg and eats into the seed. Wherever there is a large hole in the kernel through which a weevil or moth has left the seed **there is just as surely another hole,** perhaps so small that it can not be seen without a magnifying glass, somewhere else in the seed, **through which the insect entered.** When the young insect bores into the seed it is hardly larger than a "red bug" or "chigger," so naturally the hole it gnaws is very small. Like other animals, however, it grows, and by the time it is a full-grown insect it has to gnaw a much larger hole to get out of the seed.

## WHY WEEVILS APPEAR TO DEVELOP SPONTANEOUSLY.

Weevils seem to many to appear spontaneously in corn or other grains because, when they are few in number, they feed chiefly between and in the kernels, and much of the damage they do is out of sight. As the infestation increases, however, they eat out more and more of the inside of the kernels and are forced to crawl out in search of more food, and by this time they have increased so that there are literally millions of them. Because many do not notice weevils until the weevils have already done much damage and have begun to crawl about in such numbers that they can not longer be overlooked, it is said that they develop "spontaneously." It is also true that on a cool day weevils hide in the grain and seem to be absent, whereas on a warmer day they swarm over the grain and bins, thus giving the impression to one who before had examined his corn superficially on cool days that they have developed "spontaneously."

The following figures show how slowly a few weevils will increase numerically as compared with the enormous increase of a larger number. On page 12 it has been stated that a weevil can become

full grown in from 25 to 33 days. Assuming that it takes four weeks for a weevil to mature, that the females and males are equal in number, that each female lays 200 eggs, and that all these eggs hatch and live to mature, the possible increase of one pair of weevils in 24 weeks will be as follows:

*Possible increase of one pair of weevils in 24 weeks.*

| | | |
|---|---|---|
| 1 pair in 4 weeks could produce..... | 200 weevils, or ..... | 100 pairs. |
| 100 pairs in 4 weeks could produce..... | 20,000 weevils, or ..... | 10,000 pairs. |
| 10,000 pairs in 4 weeks could produce..... | 2,000,000 weevils, or ..... | 1,000,000 pairs. |
| 1,000,000 pairs in 4 weeks could produce..... | 200,000,000 weevils, or ..... | 100,000,000 pairs. |
| 100,000,000 pairs in 4 weeks could produce..... | 20,000,000,000 weevils, or ..... | 10,000,000,000 pairs. |
| 10,000,000,000 pairs in 4 weeks could produce ..... | 2,000,000,000,000 weevils, or ..... | 1,000,000,000,000 pairs. |

## METHODS OF CONTROLLING WEEVILS.

Reduction of weevil injury to corn may be brought about by the concentration of all efforts on the handling and treatment of corn after it has been dried and placed in storage. It is preferable, however, *in addition*, to adopt any good cultural method likely to lessen the number of weevils on ears intended for storage.

### CULTURAL DETAILS OF VALUE IN LESSENING NUMBER OF WEEVILS ON CORN AT HARVEST TIME.

It has already been stated (p. 8) that "black" weevils can fly from the cribs to the cornfields, and that many believe that some of the weevils live over the winter in neighboring woods or other sheltered places. It has been noticed that corn maturing on rows nearest the woods, when these are close to the cornfields, is usually more seriously infested than corn on rows farther from the edges of the field. It has also been stated (p. 9) that weevils seem to have the ability to detect the earliest ripening ears, and fly to them about the time the kernels reach the roasting-ear stage. The weevils will be seen on exposed kernels of such ears and between the leaves of the husks if these are carefully pulled away from the tip of the ear. In some localities early maturing fields of corn seem to attract practically all the weevils in a neighborhood, so that late-maturing fields are almost weevil-free. It is known, furthermore (pp. 9 and 20), that a sound, long, close-fitting husk prevents weevils from reaching the kernels, and that if each ear of corn were thus protected and the weevils could find no food elsewhere they would starve. These facts must appeal to a practical and intelligent farmer and lead him to do at least two things: (1) **To plant the seed of a variety of corn that develops a long, tight husk,** and (2) **to use trap rows.** Furthermore, *he should harvest as soon as possible and leave in the field as few scatterings of the crop as possible in which the weevils can breed over winter.*

### PLANT CAREFULLY SELECTED CORN.

Southern farmers should plant strains of corn that produce a long, tight husk, (1) because such a covering if uninjured prevents weevils from reaching the corn; (2) because the longer the husk extends beyond the tip of the ear, the more difficult it is for the corn earworm so to damage the husk by eating out the silk and by boring holes in it that its protective value as a weevil-proof covering is impaired or ruined.

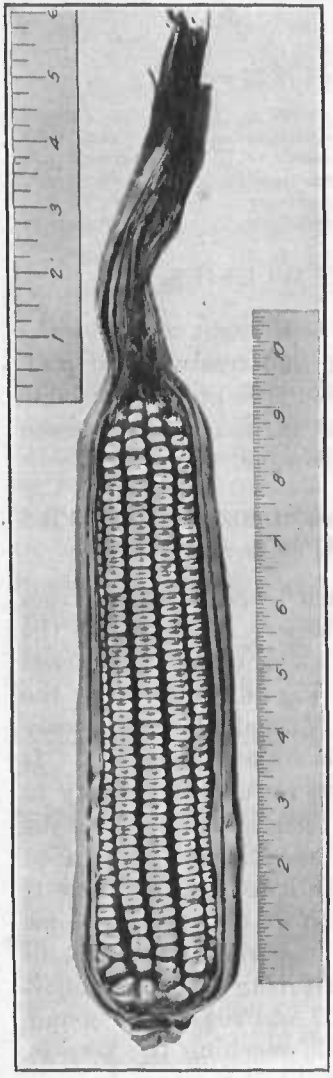

FIG. 9.—The breeder's ideal ear of corn. Husk protection like this, if uninjured by earworms, will reduce insect damage in the field and in storage to a negligible quantity. (Kyle.)

For a discussion of the corn earworm as an aid to weevil injury, see page 21. In Farmers' Bulletin 915, issued in February, 1918, there is a discussion of the value of planting only corn grown on ears with well-developed husk covering, and as a corn breeder's ideal the ear of corn illustrated in figure 9 is given. It is foolish to plant corn from ears with poor husk covering when it is known that like produces like and that such ears are always more seriously damaged by weevils. Both the Federal Department of Agriculture and the State experiment stations are at work breeding weevil-resistant strains of corn. If strains of corn can be developed—and they are being developed—that will withstand weevil attack on account of a long, tight husk, an immense saving will be affected. Every farmer should select his seed corn carefully, if for no other reason than that of lessening weevil injury.

### USE TRAP ROWS.

The fact that the outer rows of a field are often more seriously affected by weevils than other rows farther in the field can be turned to the farmers' advantage whenever local conditions make it feasible. Regarding the value of the use of trap rows the State entomologist of Alabama writes as follows:

To protect upland corn, we should at planting time provide for a few rows to be planted two or three weeks earlier, or with seed of a more rapid-maturing variety, so that they will mature earlier than the main crop and serve to concentrate the weevils thereabouts. These trap rows should be placed on the sides of the field and next to the woods, if any occur near the field. It has been found that weevil attack begins on the edges of the field and is heaviest on the side next to the woods. From six to ten trap rows may be sufficient. Nothing else need be done to vary the culture or treatment of the entire field until about five or six weeks after the roasting-ear stage has been reached by the earliest-maturing corn. At that time close examinations would show that most of the weevils in the field occurred on the ears of a few trap rows. Therefore, then gather immediately all ears from the trap rows. Leave the husk on in this case as it is our purpose, first, to remove as many as possible of the adult egg-laying weevils from the field, and, secondly, to prevent the spread of these weevils and their progeny in the first fall generation, from the trap rows into the main body of the crop. This trap corn may be fed out immediately or if it is to be kept for several weeks, it should be fumigated as soon as stored. The main crop may then be gathered at the most convenient time if weevils do not appear abundantly in it. But if weevils do become abundant, the sooner the corn is harvested and treated, the more insect injury can be prevented in it.

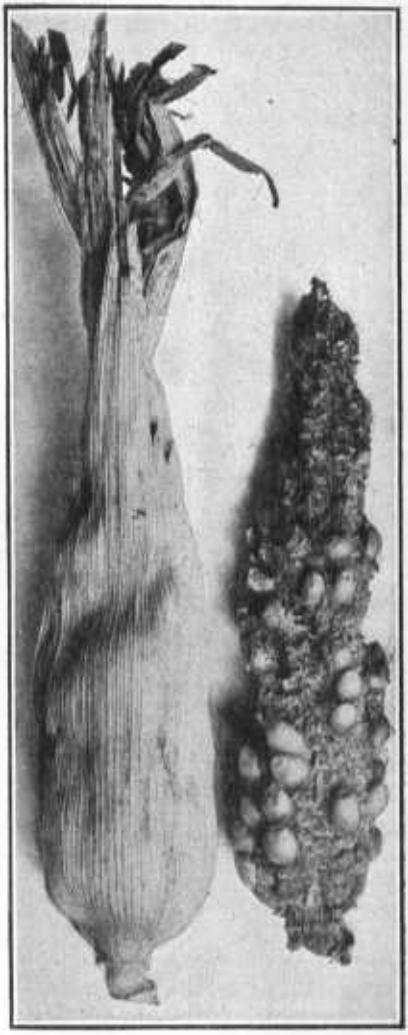

FIG. 10.—"Nubbin" ears such as these, left in the field over winter, harbor many weevils and other pests of corn and, if neglected, make it possible for these pests to cause greater injury the following season.

This is a new practice for corn farmers; but, where practical, it should be applied.

HARVEST AS SOON AS POSSIBLE.

As weevils begin to attack exposed kernels in the field as soon as the corn reaches the roasting-ear stage, the longer the crop is left in the field after it is ripe enough to harvest the greater will be the weevil injury. **Nothing can be done to kill weevils while the corn is in the field.** Get the crop into the crib, where the weevils can be controlled.

WEEVILS LIVE OVER WINTER IN NUBBIN EARS IN THE FIELD; THEREFORE GATHER ALL EARS.

In harvesting corn many farmers gather only the large, well-formed ears and leave the "nubbin" ears (fig. 10) in the field, cattle or

FIG. 11.—A neglected cornfield with broken-down stalks and many "nubbin" ears. Such fields harbor weevils throughout the winter, give the weevils a better start the following season, and furnish weevils for more prosperous neighboring fields.

hogs being turned into the cornfield later to feed down the stalks and ears missed at harvest time. In figure 11 is shown a neglected cornfield in Florida in March, with broken-down stalks and nubbin ears of the previous season still unfed. While such ears may not be worth gathering, they harbor large numbers of weevils over winter and make it easy for weevils to be present in large numbers the next season. Every precaution should be taken to lessen the abundance of weevils in the field. If the weevils can be starved out in the field and killed in the corn in storage by a well-directed community campaign, conducted by county agents, much will be done toward lessening weevil damage in any community.

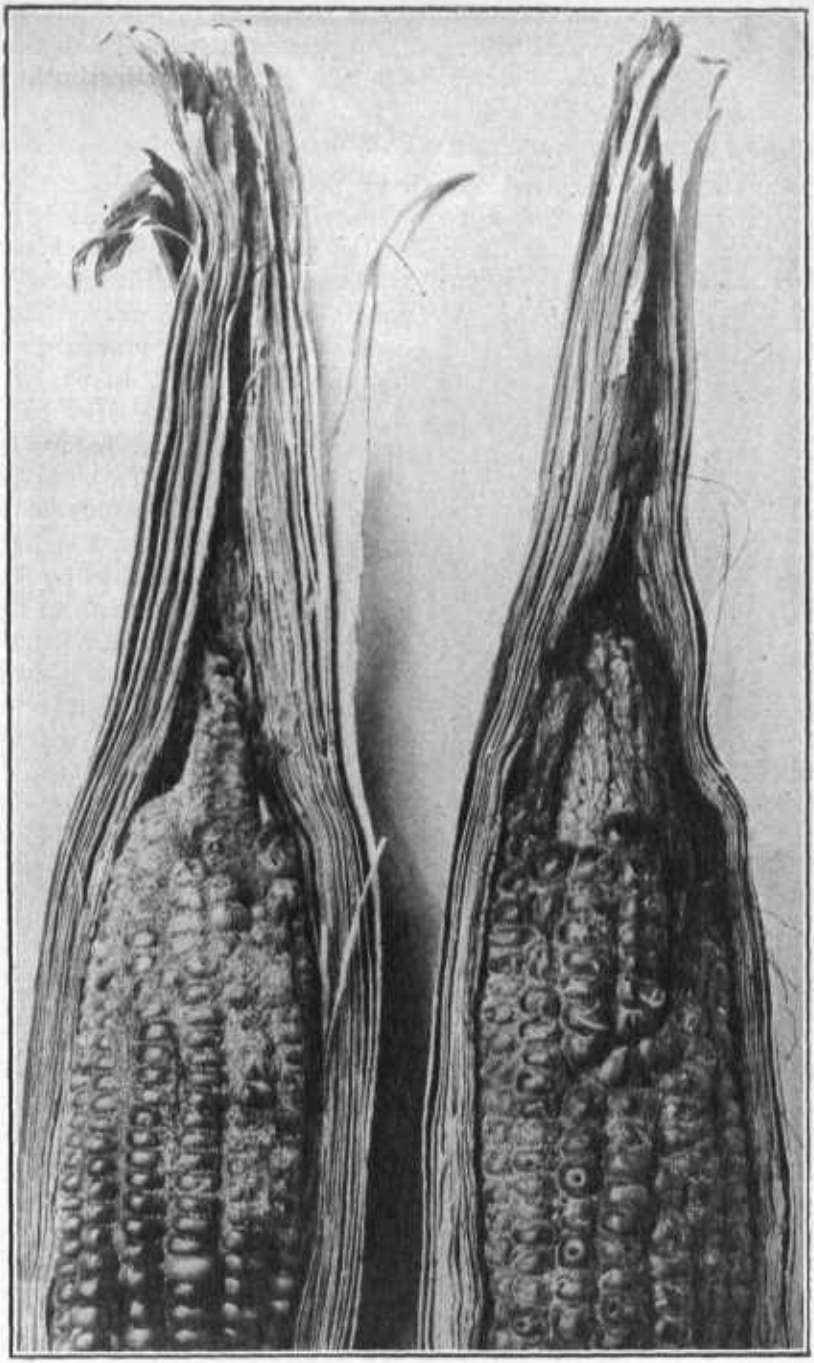

FIG. 12.—Two ears of flint corn selected in March from a Florida crib by a county agent as representative ears well protected by the long, tight shuck and, therefore, supposedly weevil proof. The removal of a portion of the shuck proved that the corn earworm had ruined the protective feature of the shuck by entering the tip of the ear and eating out the silk. As shown by the illustration, the weevils were then able to crawl down the silk channel and attack the kernels. The white streaks on some of the kernels on the ear to the right are the tunnels just beneath the skin made by the weevil grubs.

### DECIDE WHETHER TO STORE CORN IN THE SHUCK OR SHUCKED.

In protecting corn in storage from weevils it must be decided, first, whether to store the crop with the husks on, "slip shucked" or "sli shucked," or shucked.

### THE LONG, TIGHT HUSK PROTECTS; TAKE ADVANTAGE OF NATURE'S PROTECTION.

Weevils can not injure ears of corn protected with a long, tight, uninjured husk (fig. 5, *a;* fig. 9). Weevils concentrate their attack in the field on ears with exposed tips and with loose, open, or injured husks, and husks on these ears offer no real protection in storage from weevil attack. Exposed ears are often very badly damaged in the field before the corn is harvested. Take advantage of the protection offered by nature in the form of the long, tight husk to separate, while harvesting, the ears with exposed tips and loose, open, or injured husks from those with tight, long husks. Corn with long, tight husks, even in the warmest climates, will remain free from weevil attack indefinitely if the husks are not loosened or damaged by other pests or by rough handling. Store these well-protected ears in a crib by themselves.

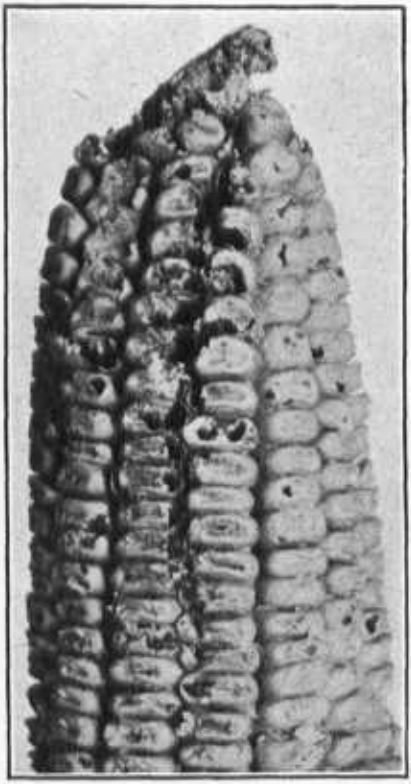

FIG. 13.—A portion of a shucked ear showing a channel cut by the earworm in the kernels, extending down the ear from the tip. Along such channels the weevils find it easy to crawl and to infest ears even when the shuck is on.

### ALWAYS SHUCK CORN WITH LOOSE, BROKEN, SHORT, OR DAMAGED HUSKS.

Ears with loose, broken, short, or insect-damaged husks (figs. 5, *b;* 6, 7, 8, 12) should be shucked before being placed in the crib. The corn on such ears is likely to be more or less injured by weevils before it is harvested and, unless shucked and treated, the weevils continue to multiply in the crib and do much damage. In addition, such ears act as centers of infestation from which weevils migrate to surrounding corn and, if not treated, they should be the first fed to stock in the fall.

### BORDER LINE BETWEEN GOOD AND POOR SHUCK COVERING.

Between the ear with a perfect, long, tight husk that protects the corn from weevils and a loose or short husk that does not protect

there is a border line hard to define. In deciding whether to store with or without the husk there are certain points to be considered, and these points will have greater or less weight according to the part of the country where the corn is grown. The farther north one goes the greater the dependence that can be placed in the long, tight husk, for, all things considered, the "black" weevils become less abundant on account of the colder winters, and the corn earworm,[1] the pink cornworm,[2] and the larger grain borer[3] do less injury.

**The Angoumois grain moth damages husked corn.**—One disadvantage in husking corn is that the kernels are then exposed to the Angoumois grain moth and other moths. These moths, as stated before, can not affect corn with a close-fitting husk.

FIG. 14—End view of ear of corn showing three holes made in the shuck covering by the corn earworm. Weevils enter such holes and reach the corn. Corn earworms do practically all their damage while the corn and husks are maturing, yet the injury they do greatly aids the weevils, both in the field and in storage.

**The corn earworm helps the weevil.**—The farther south one goes the greater is the damage caused to corn by the corn earworm. These worms that feed on the developing corn are familiar to all corn growers in the South. They feed also on the corn silk and bore holes in the husk covering and stalks. Figure 5, *a*, represents an ear unaffected by the corn earworm; the husk is long and tight and the silk is normal. In figure 5, *b*, and figures 8 and 12 the husks are sufficiently well developed to have protected the corn from the "black" weevil had not the earworm eaten out the silk from the tip of the ear, thus leaving an open channel down which the weevils crawled and so reached the corn. Note how badly affected by weevils is the flint corn on the ears of figure 12. The ears of figure 8, being entire, represent better an earlier stage of infestation, as only the corn at the tip end

[1] *Chloridea obsoleta* Fab. [2] *Pyroderces rileyi* Wals. [3] *Dinoderus truncatus* Horn.

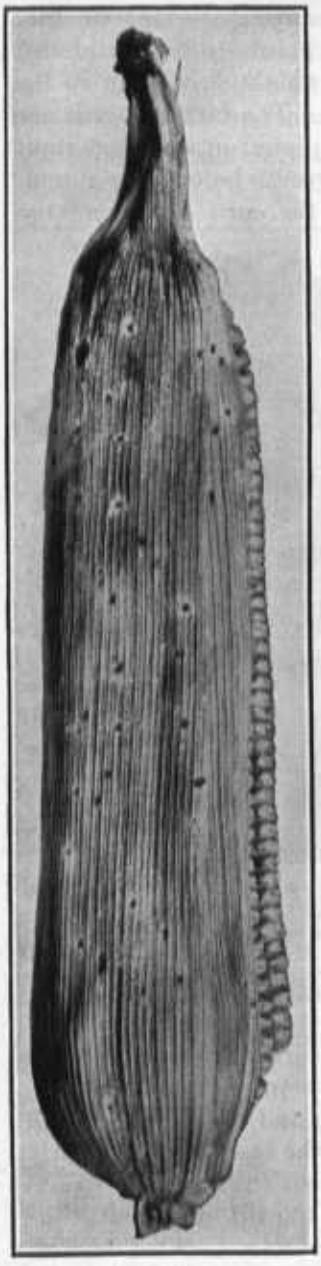

FIG. 15.—Holes in the shuck covering made by the larger grain borer. This insect bores at will through the kernels, shucks, and sacking and leaves behind holes through which the weevils and other small insects reach the corn. Under certain conditions the "black" weevils will riddle husks in a similar manner.

of the ears is weevilly. Very frequently the earworms eat channels down the side of the ear beneath the shuck, as shown in figure 13. When the worms become full-grown they gnaw a hole outward from the kernels through the husks, as illustrated by the end view of one ear showing three such holes (fig. 14). Sometimes they gnaw holes through the husks from the outside. That weevils do enter holes made by the corn earworm, even when the husk is otherwise well adapted to protect the corn, is shown by the ear of figure 5, *b*. In this ear the husk has been cut away to show the long husk with perfect silk and the white powdery mass, indicating weevil attack, over the kernels in the upper left-hand side toward the tip. This weevilly area was directly beneath a hole in the husk made by a corn earworm that merely ate through the husk from the outside. While ears protected by long, tight husks, even with the holes of the corn earworm, usually withstand weevil attack better than ears with a poorer husk covering, it should be remembered that they are not weevil-proof.

**Pink cornworms weaken husks.**—The pink cornworm is a pest that has caused considerable damage to Southern-grown corn during the past few years, particularly in Mississippi, Louisiana, and Florida. The "worms" of this insect feed not only upon the kernel and cob but also upon the husk covering and help to weaken the husk and render it less of a protection from weevils.

**Grain borers destroy husks and sacking.**—In Florida, and presumably in other points of the extreme South, the larger grain borer feeds upon the corn much as does the "black" weevil. The adult or beetle, which is only a trifle over an eighth of an inch long, bores not only in all directions

through the kernel but also through the husk covering, the closest woven bags or sacking, and even thin, soft, wooden boards. This pest has been introduced from Mexico and Central America, and while not at present very abundant, it seems to be spreading and will doubtless have to be taken into serious consideration in the future. Figure 15 illustrates the thorough manner in which this pest can perforate the husk covering of corn. Through the opening in the husk made by grain borers the "black" weevil reaches the corn, as shown by examination made at several Florida points during the winter of 1917–18, particularly at Orlando.

#### SHUCKING IN THE FIELD LESSENS THE NUMBER OF WEEVILS CARRIED INTO STORAGE.

Storing corn with the husks on means that all weevils in the husks in the field are carried into the crib. If the ears are covered with a long, tight husk, it matters little how many weevils there may be among the outer husk covering, for the weevils do not eat through and reach the corn, but this is not true with more poorly protected ears. If corn is shucked in the field, about three-fourths of the weevils are left in the field. In Alabama the State entomologist has found that corn stored with the husks on averaged 43.7 weevils per ear and that corn shucked in the field averaged but 10.7 weevils per ear. Since poor husks do not protect corn from weevil attack, storing corn with the husks on permits every weevil to continue damaging the corn in storage. By leaving three-fourths of the weevils behind in the field by breaking the ears from the stalks, the corn saved through lessened weevil damage more than offsets the cost of extra field labor.

#### SHUCKING SAVES STORAGE SPACE.

It has been found that enough corn less than six months old to make 56 pounds of shelled corn, if stored with the full husks on, requires 3.6 cubic feet of space; with "slip or sli shucks" on, 2.5 cubic feet; with ears husked, 2 cubic feet; and if shelled, 1.1 cubic feet. Corn stored with the husks on requires from three to four times as much storage space as the same amount of corn shelled, and nearly twice as much space as when husked.

#### WEEVILS CAN BE KILLED MORE CHEAPLY AND EASILY IN HUSKED OR SHELLED CORN.

Weevils can be killed more cheaply and easily in shucked or shelled corn. Because such corn takes up less space, it is easier to store it in tight containers and it takes less of the fumigating substance to protect it. The amount of space occupied by the corn in storage is an important consideration, for the amount of fumigating material necessary to treat the corn is in direct proportion to the space taken up by the corn. Thus, it requires about twice as much

carbon disulphid to fumigate corn in the husk as it does to fumigate corn shucked and from three to four times as much as if the corn were shelled.

### SOME PROGRESSIVE FARMERS SHUCK ALL CORN.

*Disregarding all arguments in favor of storing corn with or without the husk, certain progressive farmers are ignoring the husk entirety and shuck all corn before it goes into storage. It is their contention that they had rather shuck their corn as soon as possible after it is ready to harvest and get it into a well-constructed crib where they know they can keep the weevils from causing further injury by one, two, or three fumigations a year than run chances of losing their corn unshucked. This is particularly true in Florida and Louisiana, where labor can not be depended upon to separate properly the ears with a good and a poor husk covering, and where other factors, such as earworms, the larger grain borer, and the pink cornworm, are more serious factors in lessening the protective value of the husk covering.*

### TREATMENT IN STORAGE.

Corn with long, tight husks in good condition (fig. 5, *a*) needs no treatment in storage, as the husks will keep the weevils out. Such ears should be stored by themselves.

Corn with loose, poor, or damaged husks should always be shucked before it goes into storage (figs. 5, *b*, 6, 7, 8, 12). These ears should be fumigated with carbon disulphid, or "high-life," after they are placed in storage.[1] This fumigation should be done as soon as possible after the corn goes into storage, because early in the fall there are fewer weevils to kill in the kernels than at any other time. Too many wait before fumigating until the weevils taken into storage have had a chance to multiply and become very numerous and have caused so great injury that the corn appears almost alive with them. It is better to fumigate when there are fewer, rather than more, weevils, for no one fumigation is likely to kill all the weevils and their grubs. If one fumigation will kill only 99 out of each 100 of the weevils, the corn will be protected for a longer time by one fumigation if this is applied when there are only 200 weevils present than when there are 1,000,000 present. It would take the 2 weevils that escape fumigation in the first crib a long time to become numerous enough to do much injury. But the 10,000 weevils that escape in the second crib could multiply fast enough to cause much injury in a very short time if the weather were warm, as indicated by the rate of increase shown on page 15.

[1] For an exception to this recommendation see the following three paragraphs.

**How to fumigate if you have no tight storage bins or cribs sufficiently large to hold the entire crop.**—Many farmers will find at the time of this coming harvest that they do not have storage facilities large enough to hold their entire crop and at the same time tight enough for efficient fumigation of the corn. While the possession of such cribs as described on following pages is economical in the extreme South, there is little doubt that many farmers farther north, where insect damage is less, can get along without them provided they build gas-tight rooms or large boxes in which they can fumigate thoroughly portions of their crops as these are harvested and brought

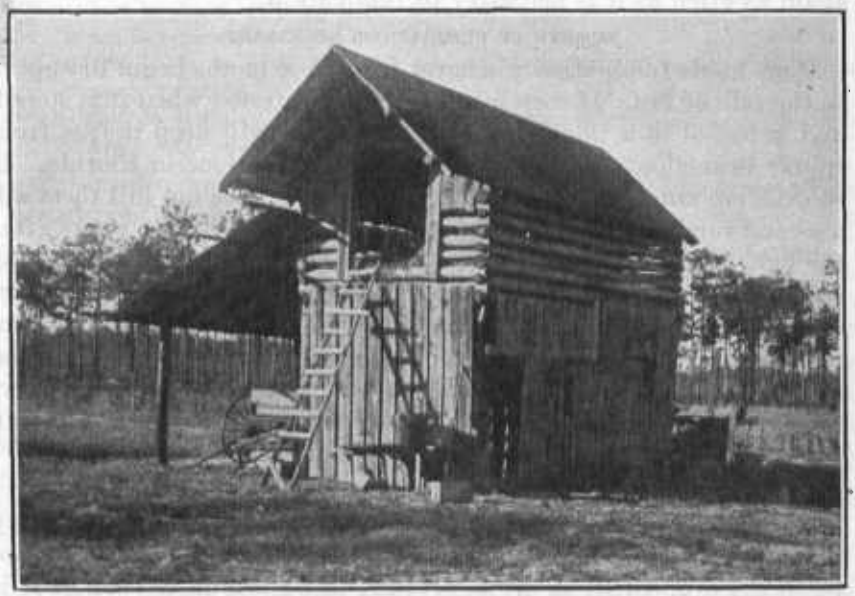

FIG. 16.—A loosely constructed combination hay loft, stable, and cornerib. Throughout the South are many such loosely constructed cribs and none of them can be satisfactorily fumigated to kill weevils.

to the barns. Such boxes (p. 29) or rooms (p. 30) can be made to suit the individual requirements, do not have to be expensive, can be constructed quickly, and will supply a great need.

When the farmer finds it desirable to fall back upon such an equipment, he should fumigate batches of corn as they come from the field and then place the fumigated portions of the crop in his regular storage quarters. In other words, these boxes or bins or rooms (whichever they happen to be) serve as disinfecting stations through which the crop passes on its way from the field to the winter storage.

Although it is preferable to put corn from the field directly into a gas-tight crib, room, or bin where it can be fumigated and left indefinitely, the method just mentioned not only is being used by certain farmers but has given success in protecting corn from weevils.

The farmer who adopts it, however, must understand the weevil problem thoroughly. He must appreciate that no matter how well he may fumigate corn in a gas-tight room or bin, it is subject to reinfestation the moment it is taken out and placed in a loosely constructed or open bin or crib (fig. 16). As stated elsewhere (p. 24), it is seldom that one fumigation kills *all* weevils, so the makeshift arrangement just described can not be depended upon for as satisfactory results as storage in a tight container. This is true for the reason that weevils can fly and will enter, from without, loosely constructed storage places, and corn must be handled over and over again as often as it is necessary to fumigate it.

### NUMBER OF FUMIGATIONS NECESSARY.

Corn needs fumigation whenever weevils or moths begin to appear in the crib or bin. If corn is only slightly infested when it is stored, and is stored in a tight crib, one fumigation will keep it free from injury throughout the fall and winter, as it has done in Florida. If weevils are numerous and the first fumigation does not kill them all, a second fumigation should be applied about two or three weeks after the first. These two fumigations, properly applied, will protect the corn throughout the winter. During the following spring the corn should be examined and if weevils begin to appear with the warm weather, the corn should be fumigated again. In southern Louisiana and in Florida, where weevils are very abundant and destructive, certain growers have kept corn in good condition in tight cribs for a year with two or three fumigations.

### WHAT IS CARBON DISULPHID?

Carbon disulphid, or "high-life" as it is called by many, is a heavy liquid that can be poured like water. It must be kept tightly stopped up in the can, bottle, or drum, because, like gasoline, as soon as it is exposed to the air it evaporates. If the stopper is not absolutely tight, cover surface of liquid with a thin layer of water. This seals the carbon disulphid so long as the water remains unevaporated. When carbon disulphid evaporates it forms a foul-smelling gas that is heavier than air. Because it is heavier than air, it sinks to the bottom of the crib or bin that is being treated, the gas replacing the air and smothering the weevils. Like gasoline, carbon disulphid will explode if fire of any sort, such as a lighted match, cigar, or lantern or an electric spark, is brought near it when it is exposed to the air. For this reason carbon disulphid should never be used in a building where there is a fire. Corn should be stored in a crib detached from other farm buildings so as to lessen fire risk. If carbon disulphid is used with the same caution as in handling gasoline, no trouble will result. Carbon disulphid is being used by many to protect corn in large cribs.[1]

[1] For full details regarding this fumigant and how to apply it, the reader should write to the Department of Agriculture for Farmers' Bulletin 799, which can be had free of cost.

**Carbon disulphid does not injure seeds for planting or for food.**—While the odor of carbon disulphid is very disagreeable, it passes off after the seeds have been well aired. If seeds are dry when fumigated they are not injured either for planting or for food.

COST OF CARBON DISULPHID.

In August, 1918, a wholesale chemical company quoted the following prices for carbon disulphid:

1-pound can, at 20 cents per pound. Cost of can included.
5-pound can, at 18 cents per pound. Cost of can included.
10-pound can, at 15 cents per pound. Cost of can included.
50-pound can, at 10 cents per pound. Can $1 extra. Can not returnable.
100 pounds, in drum, at 9 cents per pound. Drum, $7. This cost refunded if drum is returned.
150 pounds, in drum, at 9 cents per pound. Drum, $8. This cost refunded if drum is returned.
500 pounds, in drum, at 8 cents per pound. Drum, $20. This cost refunded if drum is returned.

Prices vary somewhat from the above quotations. The latest prices can always be secured by writing the Department of Agriculture. It is not necessary to pay the high prices often charged by drug stores.

AMOUNT OF CARBON DISULPHID NECESSARY FOR A FUMIGATION.

If the corn is placed in a gas-tight, or a nearly gas-tight, crib or other container, 4 to 6 pounds of carbon disulphid per 1,000 cubic feet of space is enough for thorough fumigation. In loosely constructed containers even 20 pounds per 1,000 cubic feet of space is not effective. County agents in Florida, where weevils are very injurious, keep corn uninjured by using 4 pounds of carbon disulphid per 1,000 cubic feet of space in a tight container.

COUNTY AGENTS CAN HELP REDUCE THE COST OF FUMIGATION.

County agents or groups of farmers, by cooperative buying or by pooling their interests, can purchase carbon disulphid in large quantities for local distribution. This will do away with the excessive prices often charged by the local dealers and will give each farmer the benefit of the lowest price. Each county agent should have a stock of carbon disulphid on hand for the general use of farmers in his county. It keeps indefinitely if carefully protected in tight containers.

METHOD OF STORING HAS DIRECT BEARING ON COST OF FUMIGATION.

The method of storing corn, as far as the space it occupies is concerned, has a direct bearing upon the cost of fumigation to kill weevils and other pests in storage. One standard bushel (or 56 pounds of shelled corn) occupies various amounts of space, according to how it is stored. Thus:

56 pounds of shelled corn occupies about 1.1 cubic feet of space.
56 pounds of shucked corn occupies about 1 cubic feet of space.
56 pounds of slip-shucked corn occupies about 2.5 cubic feet of space.
56 pounds of corn with full shucks occupies about 3.6 cubic feet of space.

If the inside measurements of a crib are 8 feet wide, 9 feet high in front, and 7½ feet high in the rear, the crib must be about 9 feet long to hold 300 bushels of shucked corn or about 16½ feet long to hold the same number of bushels with the husks on. The length of such a crib (which is, of course, very tightly constructed) to hold varying numbers of bushels and the amount and cost of carbon disulphid necessary for fumigation are shown in the accompanying table. The cost of carbon disulphid is taken as 20 cents per pound, which is more than it need cost if purchased in a businesslike fashion, or on the cooperative plan through county agents or groups of farmers. The amounts of carbon disulphid given in the table are based on the use of the chemical at the rate of 4 pounds per 1,000 cubic feet of space.

**Approximate length of a corncrib 8 feet wide with an average height of 8 feet 3 inches (inside measurements) necessary to hold different quantities of corn with the husks on, slip-shucked, and shucked, and the amount and cost of fumigating twice.**

| Number of bushels (56 pounds of shelled corn to the bushel). | Length of crib 8 feet wide, and 8¼ feet in average height required to hold crop. | Space occupied by crop. | Amount of carbon disulphid needed for two fumigations at 4 pounds per 1,000 cubic feet. | Cost of carbon disulphid at 20 cents per pound for two fumigations. | Cost of fumigation per bushel of corn. |
|---|---|---|---|---|---|
| **When all the husks are left on.** | | | | | |
| | *Feet.* | *Cu. ft.* | *Pounds.* | | |
| 100 | 5. 4 | 360 | 2. 8 | $0. 56 | $0.0056, or a trifle over ½ cent per bushel. |
| 200 | 10. 9 | 720 | 5. 8 | 1. 16 | |
| 400 | 22 | 1, 440 | 11. 5 | 2. 30 | |
| 600 | 32. 7 | 2, 160 | 17. 3 | 3. 46 | |
| 800 | 43. 6 | 2, 880 | 21 | 4. 20 | |
| 1, 000 | 54. 5 | 3, 600 | 28. 8 | 5. 76 | |
| **When the corn is slip-shucked.** | | | | | |
| 100 | 3. 8 | 250 | 2 | $0. 40 | $0.004, or a trifle less than ½ cent per bushel. |
| 200 | 7. 6 | 500 | 4 | . 80 | |
| 400 | 15. 1 | 1, 000 | 8 | 1. 60 | |
| 600 | 22. 7 | 1, 500 | 12 | 2. 40 | |
| 800 | 30. 3 | 2, 000 | 16 | 3. 20 | |
| 1, 000 | 38 | 2, 500 | 20 | 4. 00 | |
| **When the corn is shucked.** | | | | | |
| 100 | 3 | 200 | 1. 6 | $0. 32 | $0. 0032, or about ½ of a cent per bushel. |
| 200 | 6. 1 | 400 | 3. 2 | . 64 | |
| 400 | 12. 4 | 800 | 6. 4 | 1. 28 | |
| 600 | 18. 2 | 1, 200 | 9. 6 | 1. 92 | |
| 800 | 24. 2 | 1, 600 | 12. 8 | 2. 56 | |
| 1, 000 | 30. 3 | 2, 000 | 16 | 3. 20 | |

The figures given above indicate that it costs about half as much per bushel to fumigate corn stored with the husks off as it does to fumigate the same with the husks on. The actual cost per bushel for carbon disulphid for two fumigations (about one-third of a cent when the corn is shucked) is a mere bagatelle to the value of corn saved from weevils.

IF FUMIGATION IS WORTH DOING, IT IS WORTH DOING WELL.

The county agents throughout the South have the important task of impressing upon the individual farmer (as a bulletin often can not) the fact that fumigation carelessly done is not efficient or to

FIG. 17.—Shed belonging to a poor farmer. This man had little corn but it was more or less infested at harvest time. As soon as it was dry enough, he shelled it, placed it in various tight boxes in his shed, and fumigated with carbon disulphid. Examination of the seed in March proved it to be in good condition.

be recommended, except in an emergency as a partial check to weevil ravages. Cribs or rooms in which corn is stored for fumigation must be constructed very tightly. The average corncrib (fig. 16) found throughout the South is well-nigh useless for fumigation. It is not difficult to make a crib or other container that is practically gas tight, and the corn and chemicals saved quickly repay more than the entire cost of construction.

FUMIGATION DOES NOT NECESSARILY REQUIRE EXPENSIVE EQUIPMENT.

Whatever the necessary costs of providing the container suitable for killing weevils by fumigation throughout the Gulf Coast region, the investment is a good one.

One farmer in Florida, growing corn only for a few chickens, has solved his weevil problem by shelling his corn and storing it in ordinary dry-goods boxes, which he has fitted with hinged covers and lined with several thicknesses of ordinary wrapping paper well lapped at the edges and at the corners of the box. The thicknesses of the paper lining held the carbon disulphid until the gas killed the weevils and prevented further injury during a period of six to seven months after harvest. His was a homely equipment (fig. 17), but it served his purpose.

A water-tight barrel, a good galvanized iron garbage can, a large kettle, or a wash boiler, are just a few of the ordinary articles about the farm that can be used for fumigating small quantities of seeds. Of course, they must all be containers that can be either tightly closed during fumigation or well covered.

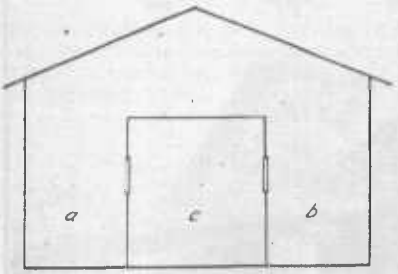


FIG. 18.—Diagram showing cross section of fumigatorium discussed on page 30.

A corn merchant in Florida, buying and selling corn for shipment by rail, found his weevil losses so great that he constructed in the center of his warehouse a boxlike room large enough to hold 4 or 5 carloads of shucked corn. He constructed this room of matched boards and painted the inside with a very thin coating of ordinary cement, which he took pains to work well into all cracks. A diagram representing a cross section of this warehouse is shown in figure 18. Newly purchased corn is thrown into the warehouse to the sides *a* and *b* on either side of the fumigating room. When the corn becomes thoroughly dry it is pitched into the fumigating room (*c*) through several windows near the top. These windows are about 2 feet square and are furnished with hinge shutters made of matched boards. There are no doors. Once the corn is all in, the required amount of carbon disulphid is poured over the corn through the windows and the shutters are closed and sealed by pasting firm paper over the cracks. Once fumigated, the corn is left sealed in the fumigating room until sold. This wholesale dealer states that he can leave such corn after it is fumigated for several months with the perfect assurance that it will not be injured by weevils until he can find a profitable market for it.

The writer visited a wholesale grocery concern in Tampa, Fla., in March, 1918, and saw another adaptation of the idea that corn can be protected from weevils by fumigation in a gas-tight room (fig. 19). The writer was told that this room, which is located on one side of

a general warehouse and close to the railroad tracks, had been constructed particularly to hold carload lots of corn that came to the warehouse infested with weevils. It was used merely as a fumigating room. The door is wide enough for laborers unloading a car to run their trucks loaded with bags of corn directly into the room. Mr. R. L. Clute, special field agent of the department, later visited the same warehouse and secured the following dimensions and method of construction: The room is 16 by 20 feet and 9 feet high. The walls, ceiling, floor, and door are made of two thicknesses of matched boards with 2-ply tarred roofing paper between. The doorway is 3½ feet wide and the threshold is very low to admit the easy entrance of loaded trucks. During fumigation the door is held closed by the two clasps shown in the illustration and further sealed by firm paper strips pasted around and over the cracks. When the 2-ply tarred roofing paper is being placed over the first layer of boards care should be taken to have it well lapped at the corners of all walls and ceiling, as these are the places at which gas will escape most easily from the room.

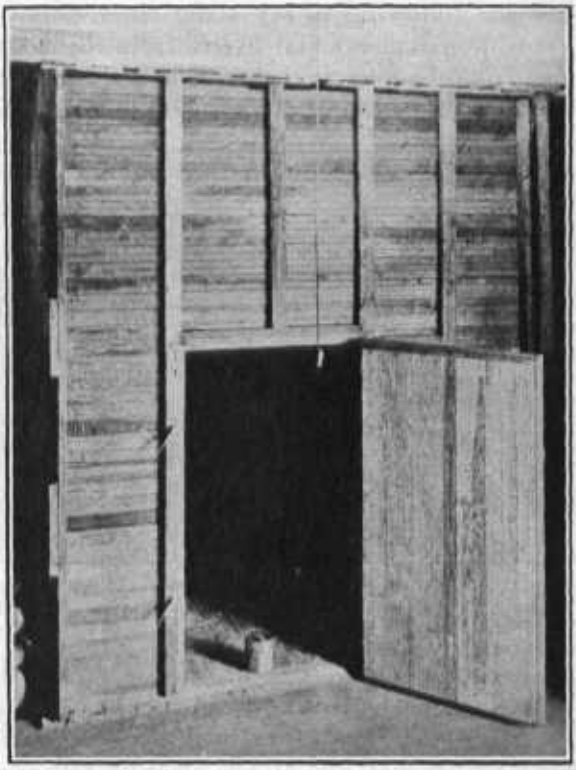

FIG. 19.—Front view of a specially constructed fumigating room used by a wholesale grocery concern at Tampa, Fla. It is made of double thicknesses of matched boards with building paper between. See page 31 of text. (Photo by Clute.)

### HOW THREE FARMERS SAVED THEIR CORN FROM WEEVILS.

One of the best arguments in favor of giving special attention to the saving of corn from weevils is the fact that large stock raisers and plantation men are giving this phase of farm economy careful attention, and that they are enthusiastic over the saving due to

fumigation. No two of the three farmers cited below have used the same equipment, for each has put into play his own ingenuity, but each, in protecting his corn from weevils by fumigation, has relied for success on a gas-tight or nearly gas-tight container of some sort. How they did it is described below:

(1) **Glen Saint Mary Stock Farm.**—The weevils were easily controlled in the two cribs shown in figure 20. These cribs were planned by H. Harold Hume, of Glen Saint Mary, Fla. Mr. R. L. Clute has the following to say about these cribs: Each is 16 by 24 feet (outside measures) and 9 feet from the floor to the eaves, and 12½ feet from the floor to the ridge pole. Each building is supported by 3 sills, 4 by 8 inches, running lengthwise. Each of these rests upon

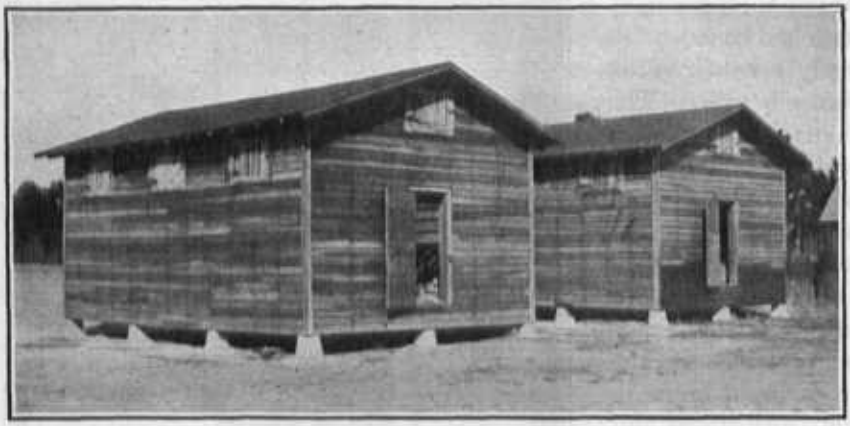

FIG. 20.—Two cribs, such as any farmer can build, that have given satisfaction in protecting Florida corn from rats and weevils. See page 32 of text. (Planned and photographed by H. H. Hume.)

four concrete blocks 8 by 8 inches square at the top, 12 by 12 inches square at the bottom, and 15 inches high, as shown in figure 20. The floor joists are 2 by 8 inches and the rafters and side studdings are 2 by 4 inches, and all are placed 2 feet apart. At each corner of the crib is a 4 by 4 studding. A 2 by 4 plate is on top of the studdings and extends on all four sides of the crib. Extending across the crib, from plate to plate, are three 2 by 4 inch timbers placed 6 feet apart, which prevent spread of walls. The floor is made of 12 by 1 inch rough boards running diagonally across the crib; over these is 3-ply tarred roofing and above this paper matched flooring well driven together. The floor extends to the outer edge of the sills and no places are left below for a rat to stand and gnaw a hole through the floor. Drop-siding is nailed to the studdings on the outside. On the inside of the studding ½-inch rough cypress timber is nailed, over which is tacked XX building paper, which in turn is covered by 6 by 1 inch matched boards firmly driven together.

The rafters are covered with 6 by 1 inch matched boards well driven together and over these is laid stone-covered roofing material carefully cemented at all joints and well nailed down. The boards and building paper lining the inside of the crib extend to the roof boards and make the walls of the crib absolutely tight. At each end of the crib is a door, 6 by 2½ feet, and below the roofing on each side and under the gable are other hinge doors or windows, 2½ by 3 feet, used in filling the crib. When the crib is being filled, cleats are nailed on the inside across the doorway. All doors are made of ½-inch boards and 2 by 1 matched boards with tarred paper between, and when closed fit tightly. The cribs are painted with carbolineum. Each cost $190 and has a capacity of about 1,750 bushels of shucked corn.

Slip-shucked corn was placed in each crib during October, 1917, and received three fumigations: First on November 8, second on December 3, and third on December 31. After the carbon disulphid was poured over the corn, strips of firm paper were pasted over the cracks, and about all doors and windows. It is stated that during fumigation the odor of the gas could not be detected. On April 9 an examination showed very few weevils present and the corn was in excellent condition.

(2) **Raceland Plantation, Lafourche Parish, La.**—This plantation had 13,000 bushels of corn that was being eaten up by weevils and had to be treated. It was to be stored in a large frame barn 84½ feet long, 34½ feet wide, and 23 feet from the ground to the ridgepole. The barn had a driveway through the center with bins on each side. This barn was too full of cracks to be used for fumigation, so an agricultural engineer was consulted. It was decided to close the driveway and put in the corn from the sides and ends. Floor joists were put in and the entire building refloored with matched boards. The sides and end walls and overhead were likewise ceiled with matched boards, well driven together, with the exception of the necessary doors and windows through which to enter and fill the building. Old boiler flues drilled through with holes were placed on the floor with the outside end projecting through the wall to give ventilation at the bottom. Fifteen large manholes were cut through the ceiling to give access for treating the corn and provided ventilation at the top. The barn, remodeled, held about 13,000 bushels of shucked corn. Filling by hand was difficult, but future crops will be easily handled by machinery known to all plantation managers.

Two 500-pound drums of carbon disulphid were purchased at 10 cents per pound (freight charges $5 extra). The chemicals came soon after the crop was placed in the barn and one drumful (500 pounds of carbon disulphid) was emptied into 15 buckets, and 15

men, each carrying one of the buckets, entered through the manholes and went to places on top of the corn where shallow holes previously had been scooped out. At a given signal each man emptied his bucket of carbon disulphid into the hole and climbed back through the manhole and closed the trap door. Some time after the corn was treated it was examined, and on almost every ear from 1 to 10 dead weevils were found. It was reexamined several times, but as no living weevils were found, the owners believed (in May, 1918) that the weevils would not cause injury even during the following summer. It was estimated that from 1,000 to 1,500 bushels, worth at least $1,500 to $2,500 (1917–18 prices) had been saved. It cost $500, including the addition of the driveway that increased the barn capacity 50 per cent, to weevil-proof the barn. If 10 per cent of this, or $50, be charged to the 1917 crop, together with one drum of carbon disulphid ($50), freight on the drum ($2.50), and labor for applying the carbon disulphid ($1.50), the total cost of this single successful fumigation was $104. Or, if the entire cost of weevil-proofing the barn and the cost of the two drums of carbon disulphid, freight, and application be charged against the 1917 crop alone, a total of $606.50, the saving would have ranged from $893.50 to $1,893.50, according to the estimated 1,000 to 1,500 bushels of corn saved from the weevils. This leaves the owners with a weevil-proof structure and 500 pounds of carbon disulphid for future use free from all encumbrance.

(3) **Newman Dairy Farm, Donaldsonville, La.**—Mr. J. K. Newman, of New Orleans, the largest dairy farmer of Louisiana, has had built on his farm at Donaldsonville two galvanized-iron containers similar to several containers now on the market, but embodying certain improvements originated by him. One of these containers is shown in figure 21. It is 18 feet in diameter, 17½ feet high, excluding its roof, and estimated to hold about 2,500 bushels of shucked corn.

Mr. Thomas H. Jones, of this Bureau, has the following to say about Mr. Newman's tanks:

> Each is cylindrical with a conical roof. They are made of galvanized iron in sections; the sections have outside flanges which are bolted together after elastic cement has been placed between the surfaces of the flanges that come in contact with one another. There are three small doors in each tank; two, one above the other, in one side near the base, and one in the roof.
>
> Ventilation for the corn in the tanks is provided for as follows: The tank, which rests on a cement base, has a false floor of perforated galvanized iron resting upon a wooden framework that holds it 6 inches above the cement. Around the base of the tank are six equidistant 6-inch circular openings, which open into the space between the perforated metal floor and the cement. Midway between each two of these openings is a semicylindrical perforated galvanized-iron ventilator, 10 inches in

diameter, soldered to the inside of the tank walls, and extending from the floor to the eaves. In the center of the tank additional ventilation is provided for by a central ventilator of perforated galvanized iron, extending from the false floor to a cupola at the apex of the roof. This central ventilator is 6 inches in diameter at the base, but gradually increases in size, until at the cupola it is 2 feet in diameter. All ventilator openings to the exterior are screened to prevent mice from entering and provided with hinged iron doors that can be closed tightly during fumigation.

Choice soft dent corn is stored in these containers and can be held free from weevil injury, as evidenced by a personal examination by the writer of the 1916 crop during August, 1917. These tanks are filled by a portable elevator through an opening in the roof (in illustration at head of ladder). Corn can be removed, or a person can enter, through the doors to the right at the base of the ladder. This container is more expensive than a good wooden structure, yet it is permanent if well cared for and has paid for itself several times over during the past few years. Any good concern working in galvanized products can give quotations on a tight container of this type. It has the disadvantage that moisture sometimes gathers on the inside of the tank midway between the side ventilators, and this, although it is not often the case, may cause the corn touching the tank wall to sprout.

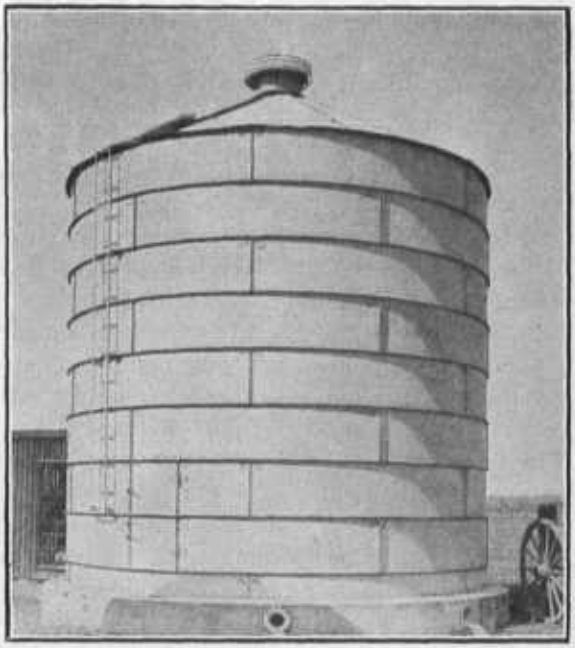

FIG. 21.—A modern galvanized-iron corncrib planned and erected by a progressive dairyman of Louisiana. Soft white dent corn has been kept in this crib in perfect condition for over a year. Weevils breed in such cribs as fast as in any, but are easily killed by fumigation with carbon disulphid. (Photo by Jones.)

**WEEVILS LIVE IN EMPTY CRIBS AND BINS AND ARE READY TO ATTACK THE NEW CROP. CLEAN OUT EMPTY BINS.**

Insects that destroy corn can live over in empty bins or cribs until the new crop is harvested. Many a crop of corn has been more seri-

ously damaged than it would have been had the old crib been thoroughly cleaned and disinfected as soon as the old crop was used up or sold. It is the stray kernels that are left carelessly lying in the bin corners, in the cracks, or beneath loose flooring that give the weevils food and permit them to multiply and get into condition to attack the new crop in force the moment it is placed in storage. Prevent this holding over of the enemies of the old crop by at once removing from the emptied bins all loose flooring, scrub down the walls, clean out the cracks, and then fumigate with carbon disulphid, if you feel that you need to. If your crib is a specially constructed one of matched boards, as described on page 32, a thorough sweeping out and scrubbing followed by a good coat of whitewash will answer all purposes. The whitewash kills very few of the corn pests, but they do not like it and usually leave for quarters more agreeable to them.

## HAVE A FUMIGATORIUM OF YOUR OWN.

A fumigatorium is a container in which anything can be fumigated. It may be a water-tight barrel, a specially constructed box, a tin pail, a large crock, a wash boiler, a corn crib, or a special room. Use your own initiative to construct one to meet your own particular needs. If you do not know how, ask your county agent, and he can tell you, or get the information within a few days by writing to your own State experiment station, or to the Federal Department of Agriculture. The facts set forth in the previous pages, 24 to 35, make it clear that you can fumigate if you pay attention to making the fumigatorium gas tight. The corn crib, illustrated by figure and described on page 32, is giving perfect satisfaction. Any carpenter can construct for you a similar one or any modification of it. Don't put time or money into a loosely constructed bin, box, or crib in which to fumigate corn or other seeds, such as cowpeas, to kill weevils. If you can not fumigate in regular storage bins, fumigate before final storage in smaller gas-tight rooms or bins, as suggested on pages 29 and 31.

**Remember, no matter how unfavorable the conditions, you can save your corn if you will exercise your own ingenuity and call upon your county agent to help you. He is there for that purpose and can pay for himself a hundred times over if you will make use of him.**